Space Weather Technical Forecast

Issued on Monday, 18 September 2023 at 13:04 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1-G2 minor/moderate storm intervals expected during day 2 (Tuesday 19th September) however, with a likely CME arrival bringing a slight chance of a G3/Strong storm. Chance of isolated R1 Minor Radio Blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours. There are currently six numbered sunspot regions and two un-numbered on the visible disc. The most active spot over the last few days was AR3429 (Cai/Beta), but this region has continued to see weakening and fragmentation within its central portion, and is now classified Cai/Beta with a corresponding slight reduction in flare risk. Four other spot groups are located in the western hemisphere, with two recently numbered groups AR3436 (Dao/Beta-Gamma) and AR3437 (Cao/Beta), showing the most recent development. The largest spot group remains AR3435 (Dho/Beta) toward the east limb.

No new Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR/ACE at L1, were at slightly elevated levels between 430-480km/s with some waning coronal hole influence likely ongoing, and perhaps evidence of a weak transient soon after midnight UTC. The solar wind density was at average levels. The IMF was steady and weak initially, 5-7nT, but increased slightly after midnight UTC, 6-10nT. The north-south component showed a similar trend varying between +6/-7nT. The phi angle has been mostly negative (toward the Sun). Geomagnetic activity, as measured by BGS, was mostly Quiet to Unsettled (Kp 2-3) but reached Active levels (Kp 4) between 18/0000-0600UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was initially at Background levels. A slight increase in flux levels was observed from 18/0430UTC, with a peak of 2 pfu, before reducing again over the last few hours. GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate levels. The associated 24-hour fluence was well below the Active threshold, with 2.44e6 integrated pfu observed at 18/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low activity expected, but there remains a chance of isolated M-Class flares throughout the period.

Solar Wind / Geomagnetic Activity: There are currently two CMEs that feature in the forecast. The first CME was likely associated with an M2.4 flare from AR3229 at 14/2126UTC. With a possible glancing arrival suggested during day 1 (18 Sep).
The second a large filament eruption and associated CME which occurred early on the UTC day of 16 Sep has been analysed and modelled in Enlil, which suggests a likely Earth directed

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component with an arrival time during Day 2 (19 Sep).

Quiet to Unsettled conditions at first on Day 1 (18 Sep), though there remains a chance of G1 minor storm intervals from a potential glancing CME during the second half of Day 1 (18 Sep). G1-G2/Minor-Moderate storm intervals expected during day 2 (19), with a Chance of a G3/strong storm due to the expected arrival of the large CME from the filament eruption on 16 Sep, potentially combined with coronal hole influence. CME and coronal hole effects perhaps lingering into day 3 (20 Sep) but likely waning somewhat by day 4 (21 Sep).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background levels, with a daily slight chance of an enhancement should any larger flares occur.

High energy (greater than 2 MeV) electron flux is likely to be suppressed at Normal Background levels at GEO through much of the period, but perhaps with reduced confidence given likely CME influence. Overall, the 24-hour fluence is expected to remain below the Active threshold throughout the period, with reducing confidence later in the period.

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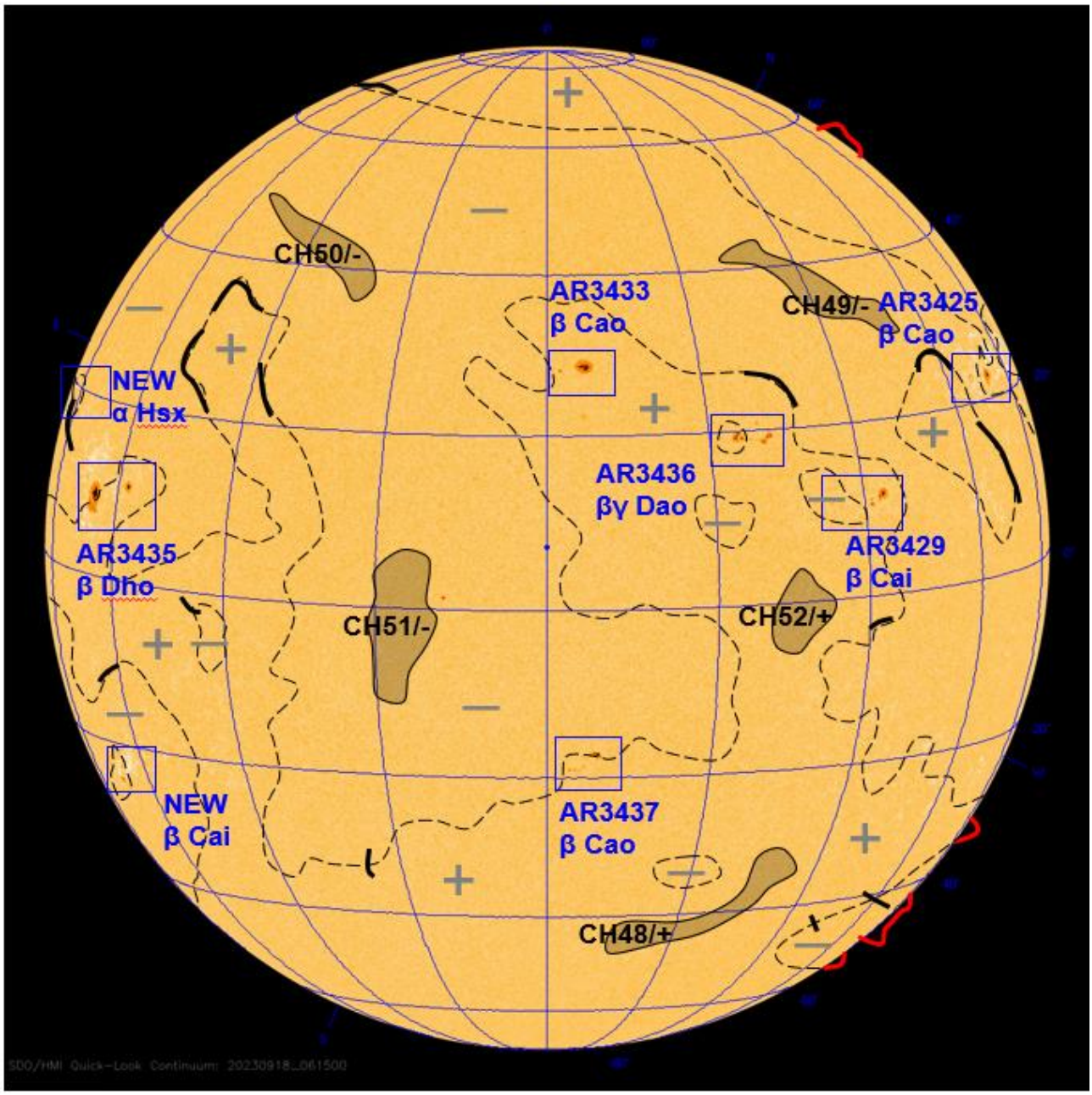
Figure 1. Solar Analysis Valid 18/0700 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:
There are currently two CMEs that feature in the forecast.

The first CME was likely associated with an M2.4 flare from AR3229 at 14/2126UTC. With a possible glancing arrival suggested during day 1 (18 Sep).

The second and probably the most significant CME in the forecast is from a large filament eruption, which occurred early on the UTC day of 16 Sep. The large filament was dominant in the central-north disc and lifted off the disc early on 16 September. This produced an asymmetric halo CME seen clearly in LASCO-C2 and C3 coronagraph imagery, also STEREO-A, with the bulk of the material heading to the south and west. The CME has been analysed and modelled in Enlil, which suggests a likely Earth directed component with an arrival time during Day 2 (19 Sep).

Outside of CME influence the solar wind sees lower than average forecast confidence through the period, complicated by the potential influence from one or more coronal holes. With CH49/- and CH52/+ in the northwest perhaps having an impact from late day 1 onwards. A lack of reliable persistence data further reducing confidence and ENLIL model output has likely not yet assimilated these features.

Quiet to Unsettled conditions at first on Day 1 (18 Sep), though there remains a chance of G1 minor storm intervals from a potential glancing CME during the second half of Day 1 (18 Sep). G1-G2/Minor-Moderate storm intervals expected during day 2 (19), with a Chance of a G3/strong storm due to the expected arrival of the large CME from the filament eruption on 16 Sep, potentially combined with coronal hole influence. CME and coronal hole effects perhaps lingering into day 3 (20 Sep) but likely waning somewhat by day 4 (21 Sep).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	30	80	60	30
Strong	G3	No	5	30	10	5
Severe	G4	No	1	2	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/0600	Partial	AR3429	M2.4 flare	500 km/s	18/1200 UTC	Glancing blow
16/0800-1000	Full halo	Filament eruption	Centre	635 km/s	19/1200 UTC	Low confidence but potentially impactful

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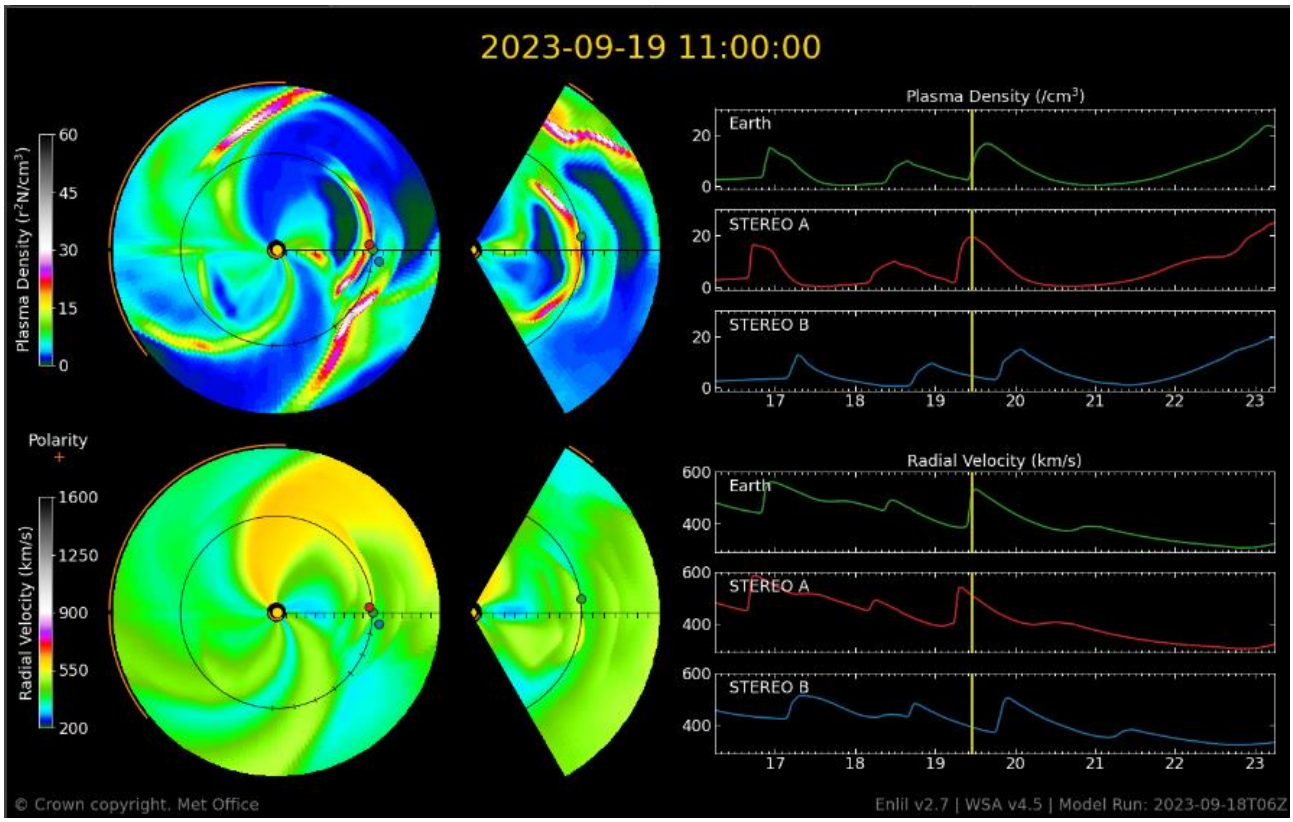
Figure 2: MOSWOC Enlil model showing potential arrival on 19th.



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Radio Blackouts - X-Ray Flares:

There are currently six numbered sunspot regions and two un-numbered on the visible disc. AR3429 has continued to see a general weakening with some waxing/waning of the small intermediate and trailer spots. The largest region on the disk is currently AR3435 on the east limb Dho/Beta. Newly numbered AR3436 (Dao/Beta-Gamma) and AR3437 (Cao/Beta) continue to develop, with AR3436 showing some mixing of magnetic polarities. Remaining groups are largely unchanged in overall development.

Solar activity has been Low over the past 24 hours, with minor C-flare activity. Activity is expected to remain generally low, but with a chance of M-class flares.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at Background levels, but with a daily slight chance of flux levels rising in response to any significant flaring, particularly from AR3429 as it rotates across the western disc. A slight increase in flux levels was observed from 18/0430UTC, with a peak of 2 pfu, before reducing again over the last few hours.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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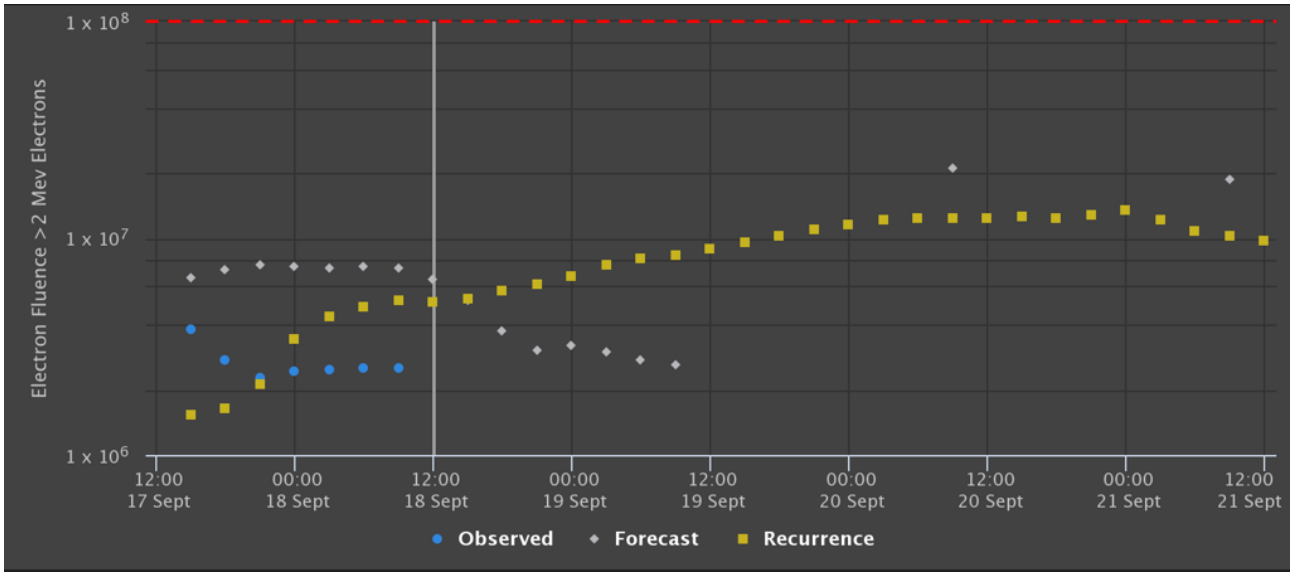
High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2MeV) electron flux levels are currently at Background levels. An uncertain forecast during the period, with geomagnetic activity associated with the expected arrival of one or CMEs in the coming days likely to impede any prolonged rise. There remains a possibility coronal hole influences will increase solar wind speeds, which may result in increased electron flux levels though confidence is low.

The 24-hour fluence is currently below the Active threshold, with current MOSWOC REFM model output likely providing reasonable guidance. Forecast is lower confidence however given uncertainties above, with an increasing risk of breaching the active threshold into the period.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}\,sr^{-1}\,day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: MOSWOC REFM output.



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